
# 7 How Do States Assure Conformance with the National ITS Architecture?

Most of us have an idea of what is meant by the architecture of a building. It means the overall design of a building, including the structural elements and style. The information technology community uses the term to mean the same thing with respect to information systems.

> ***Architecture***
>
> *The overall structure (elements and interfaces) and unifying design characteristics (principles, concepts, and standards) of a system.*

## 7.1 What is the National ITS Architecture?

The Intelligent Transportation Systems (ITS) Program has developed a National ITS Architecture, which was defined and baselined in 1996. ITS has been interpreted to be a "system of systems," and its architecture serves as the master blueprint for ITS to assist in achieving the United States Department of Transportation (USDOT) vision of building a transportation system that is international in reach, intermodal in form, intelligent in character, and inclusive in nature.

The National ITS Architecture is an organized approach to implementing, in a consistent manner across the U.S., the various ITS user services envisioned for the next 20 years or more. It is a framework that lays out the boundaries, players, and strategies for the process of information management. This framework provides guidance in developing standards and making deployment decisions that result in safety, efficiency, economies of scale, and national interoperability. The development of the National ITS Architecture was a 3-year effort and was the first step toward achieving the vision Congress put forth for ITS in 1991; a vision of a seamless, multimodal, national intelligent transportation system that would have a consistent personality across this country.

The National ITS Architecture is comprised of several "subsystems" that are components of the overall ITS. Commercial Vehicle Operations (CVO) comprises four of these subsystems, and a more detailed architecture consistent with, and derived from, the National ITS Architecture exists to support it. The ITS/CVO Architecture was developed to

> ***National ITS Architecture***
>
> *The functions associated with ITS user services; the physical entities or subsystems within which the functions reside; the data interfaces and information flows between physical subsystems; and the communications requirements associated with the information flows.*

provide a technical framework for the development of systems for implementing various ITS/CVO user services that utilize information systems and networks. It is intended to guide implementations throughout all of North America, to foster commercial motor vehicle safety and efficiency across the United States and beyond its borders into Mexico and Canada.

## 7.2 What is the CVISN Architecture?

The Commercial Vehicle Information Systems and Networks (CVISN) architecture is a framework that serves as guidance for stakeholders in the CVO community to develop information systems, standards, interfaces, and subsystems to support identified user services. These user services are based upon stakeholder needs and requirements, and are an outgrowth of analyzing "operational scenarios" within the commercial motor vehicle environment.

The CVISN architecture is a subset of the National ITS Architecture. Figure 7-1 is a version of the National ITS Architecture's "sausage" diagram that highlights the CVO-unique subsystems with thick borders and shading.

The top-level picture of the CVISN architecture in Figure 7-2 shows the CVO-unique subsystems from the National ITS Architecture, the equipment packages (shown as round-cornered boxes) in those subsystems, the other subsystems and terminators they connect to, and where standards are to be used.

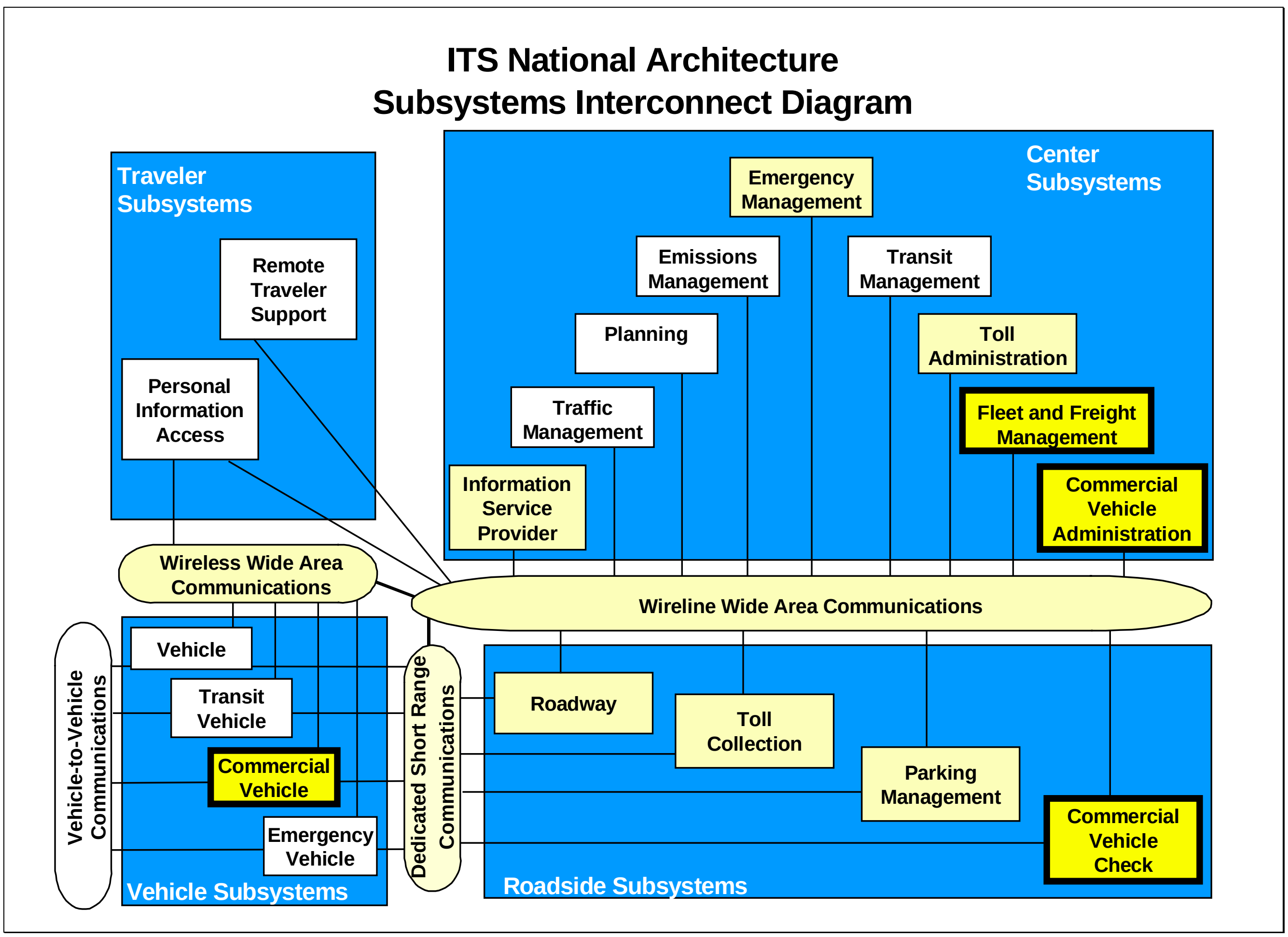


**Figure 7-1 ITS National Architecture Subsystems Interconnect Diagram**

The CVISN architecture is a concept. It is defined by a set of documentation that describes requirements, standards, operational concepts, notional designs, implementation guidance, and other supporting technical and management information. The architecture defines:

- The functions associated with ITS/CVO user services,
- The physical entities or subsystems within which such functions reside,
- The data interfaces and information flows between physical subsystems, and
- The communications requirements associated with information flows.

The CVISN Architecture is the CVO information systems and networks portion of the National ITS Architecture. The CVISN Architecture documentation begins with the National ITS Architecture and adds more detail in some areas [e.g., operational concepts and the Electronic Data Interchange (EDI) message requirements] to facilitate further development.

Factors that influence the architecture are constantly changing. The needs of motor carriers evolve in response to changes in the marketplace caused by factors such as global competition.

New technologies emerge and old ones become obsolete. Public policy and legislation change. In order to keep the architecture current and useful, the

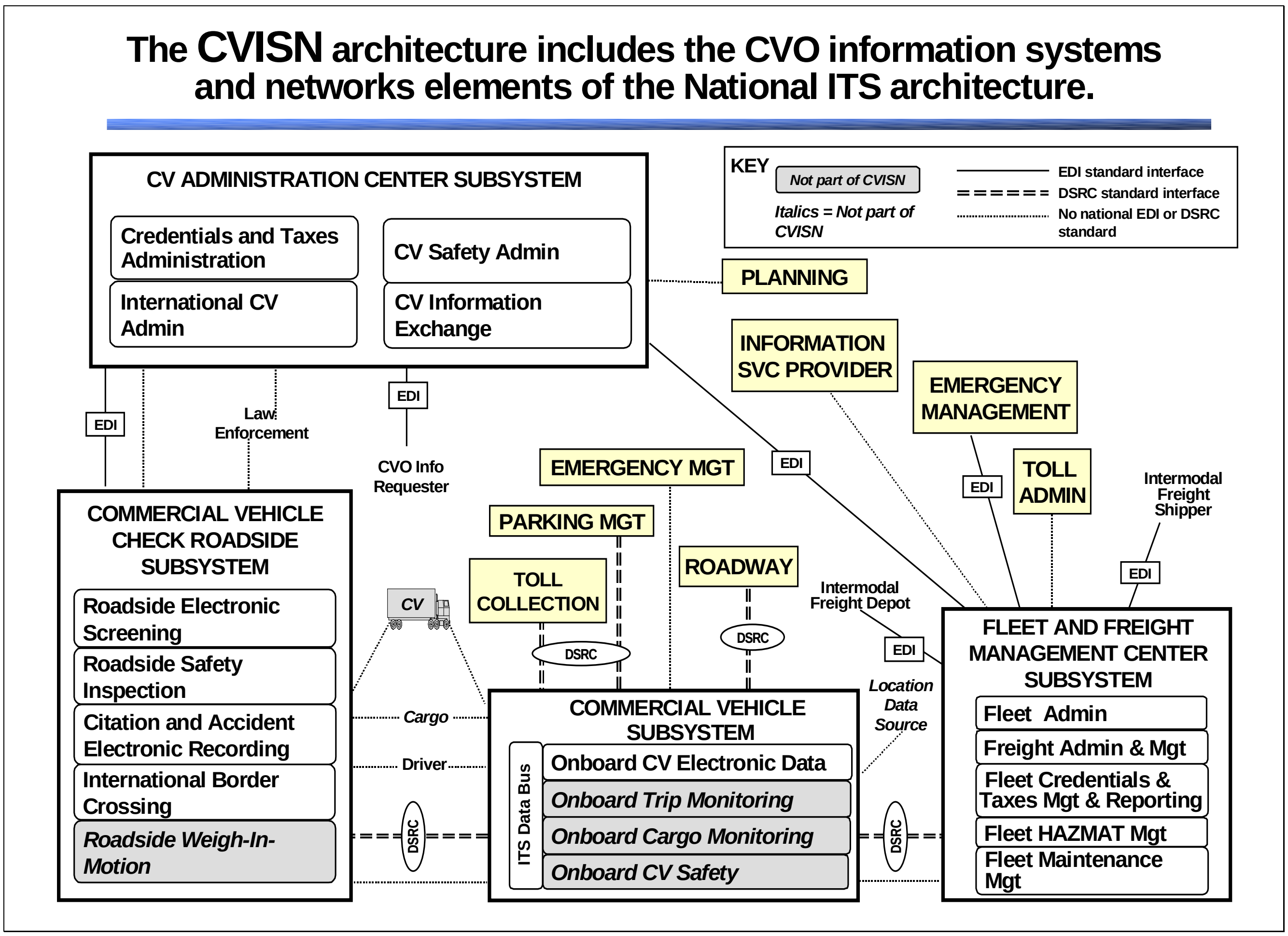


**Figure 7-2 CVISN Architecture**

Federal Motor Carrier Safety Administration (FMCSA) plans to continue to maintain and enhance the architecture at least through the Level 1 deployment period.

> ***CVISN Architecture***
>
> *The ITS/CVO information systems and networks portion of the National ITS Architecture. The CVISN Architecture documentation begins with the National ITS Architecture and adds more detail in some areas to facilitate further development.*

## 7.3 What Does it Mean to "Conform to the Architecture?"

In order to conform to the ITS/CVO Architecture, deployed systems must satisfy a set of conformance criteria. These criteria are defined in the CVISN Operational and Architectural Compatibility Handbook (COACH). The COACH fundamentally requires deployed systems to **adhere to open interface standards, support CVISN operational concepts, and use shared process and data definitions**.

The COACH documents are recommended as a relatively concise set of checklists to assist at various checkpoints. The COACH is divided into five parts as detailed in Table 7-1.

**Table 7-1 COACH Parts**

| Part | Description |
|---|---|
| **Part 1** | Operational Concept and Top-Level Design Checklists |
| **Part 2** | Program Management Checklists |
| **Part 3** | Detailed System Checklists |
| **Part 4** | Interface Specification |
| **Part 5** | Interoperability Test Criteria |

Parts 1, 4 and 5 actually specify conformance requirements. Parts 2 and 3 provide process guidance that is intended to help organize projects and develop designs that lead to conforming systems.

The COACH Part 5 states these requirements in a manner that is specific and testable. An example of a COACH conformance requirement is:

*3.1 1. The CAT sends each kind of valid credential application/modification using ANSI ASC X12 EDI transaction set 286.*

Conformance can be thought of at three levels: technical, operational, and administrative. A definition and example of each is shown in Table 7-2.

**Table 7-2 Levels of COACH Conformance**

| Conformance Category | Definition | Example |
|---|---|---|
| **Technical Conformance** | Hardware and software products and systems meet specific standards. | ▪ A dedicated short range communication (DSRC) tag is certified to meet a particular standard.<br>▪ A carrier automated transaction (CAT) is certified to pass applicable interoperability tests. |
| **Operational Conformance** | Systems and associated operational practices meet specified conformance criteria. | ▪ Weigh stations use a common criterion or algorithm for determining which vehicles should be given a "red light" during an electronic screening process.<br>▪ States follow uniform practices for verification checks on International Registration Plan (IRP) applications. |
| **Administrative Conformance** | Programs run by different states follow common policies. | ▪ States agree to honor tags provided by other states in the electronic screening program supported by their state.<br>▪ States agree to make interstate credentialing status data from their systems available to Safety and Fitness Electronic Records (SAFER). |

The ITS/CVO architecture specifies several American National Standards Institute (ANSI) Accredited Standards Committee (ASC) X12 EDI, American Society for Testing and Materials (ASTM), and Institute of Electrical and Electronics Engineers (IEEE) interface standards. The standards primarily address the exchange of information between public and private entities. Conforming to the architecture is essentially using these standards to attain technical conformance and supporting common administrative policies and operational practices to achieve operational and administrative conformance. The common operational practices and administrative policies are not precisely defined at this point in time. They are evolving as stakeholders define them through operational practice agreements worked out in stakeholder associations such as American Association of Motor Vehicle Administrators (AAMVA), American Association of State Highway and Transportation Officials (ASHTO), American Trucking Associations (ATA), Commercial Vehicle Safety Alliance (CVSA), International Full Tax Agreement (IFTA), IRP, Institute of Transportation Engineers (ITE), ITS America, National Electrical Manufacturers Association (NEMA), National Private Truck Council (NPTC) and others.

## 7.4 What are the Benefits of Conformance to the Architecture?

The primary goal of the architecture is to allow stakeholders to achieve geographic and functional interoperability of some ITS/CVO systems (e.g., credentialing software) and interchangeability of some CVISN systems (e.g., DSRC tags). Interoperability refers to the ability of two or more systems or products to work together to accomplish a shared function. Interchangeability refers to the ability to substitute one product for another. Interoperability and interchangeability allow users to select vendors and promote development of a competitive marketplace. Figure 7-3 shows a hypothetical example of what happens when systems are not interoperable. Suppose that the desired, shared function is to have a roadside system cooperate with a national safety database to determine if a particular vehicle is known to be stolen. Assume that data is stored in a state roadside system according to license plate number. When you want to call up the safety history of a vehicle, you need to know the license plate number with this state system. On the other hand, the information in a national database of stolen vehicle information may be stored and retrieved based on the vehicle identification number (VIN). So even though both systems have information on the same vehicle, they are not interoperable because they cannot work together to accomplish the task of finding out if a vehicle is stolen. They could be made to be interoperable if they adopted a common identifier for storing and retrieving vehicle information, such as the VIN.

Although the primary goal of conformance to the architecture is to support interoperability and interchangeability, there are other benefits:

- The architecture provides a framework for **planning**.
- It identifies where **standard interfaces** are required.
- The architecture allows customers to specify the technical characteristics of procured systems necessary for interoperability.
- It provides detailed specifications to allow them to **implement and test** that interoperability characteristics have been achieved.
- It provides a framework for states to develop **operational practice agreements** that lead to administrative process uniformity and system interoperability.
- The architecture supports **market development** by providing a framework for states and motor carriers to identify common needs, thereby creating a market large enough to support investment by system integration contractors, product vendors, and service providers.

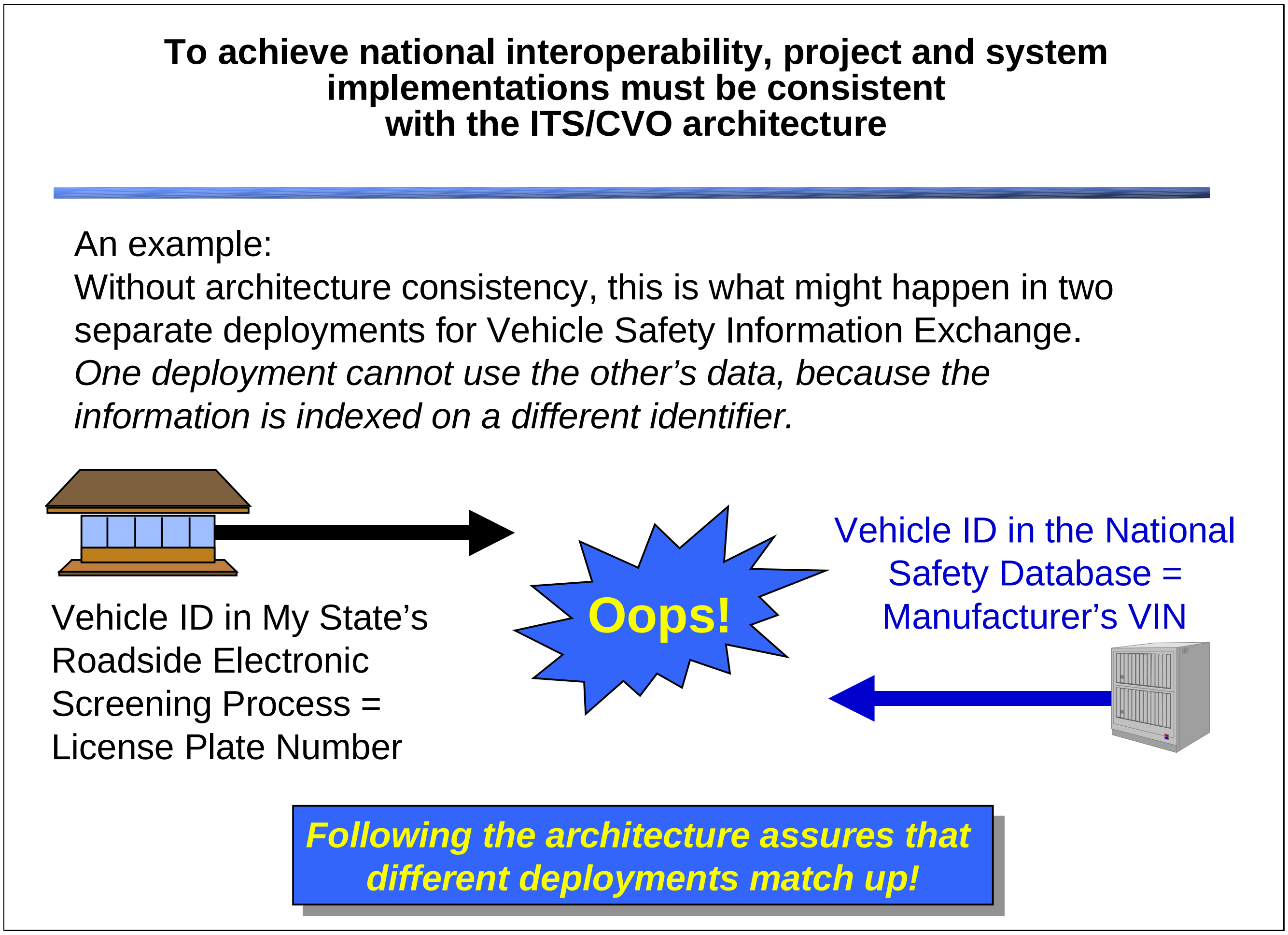


**Figure 7-3 Achieving National Interoperability**

## 7.5 Are States Required to Conform to the Architecture?

Participation in the CVISN Program is voluntary for states and carriers. However, if a state chooses to participate and to use Federal funds, some conditions apply. The U.S. Congress has mandated that the implementation of ITS using funds authorized by the Transportation Equity Act for the 21st Century (TEA-21) must be in conformance with the National ITS Architecture and Standards. The FHWA issued more specific, interim guidance in the fall of 1998.

The interim guidance will be in place as a rulemaking process proceeds. This will apply to any ITS project receiving any funding from the Highway Trust Fund. (If a project is under construction or has completed final design as of October 2, 1998, it is exempt and other exemptions will be considered.)

In the summer of 2000, the FHWA plans to issue a Notice of Proposed Rulemaking (NPRM) to begin the process of defining the conformance requirements for recipients of funds. The final NPRM has not been determined. The ITS/CVO stakeholder community currently seems to support the idea that the USDOT should require the use of USDOT-adopted standards and interoperability tests for ITS/CVO projects that are recipients of Federal Highway Trust Funds (see section of TEA-21 5206, subparagraph e). Some potential required conditions on recipients are under consideration. See Table 7-3 for Architecture Conditions and Conformance.

## 7.6 What Process is Recommended to Ensure Conformance?

The FMCSA has developed a recommended Conformance Assurance Process (CAP) to be used by states. It defines evaluation criteria for ITS/CVO architectural conformity, and establishes a mechanism for fostering conformance in a deployment. The CAP recommends that each ITS/CVO project have a plan that will consist of an incremental checkpoint system for assessing architecture conformance. At each checkpoint, documents should be submitted to a Conformance Assessment Team (COAT), described in Subsection 7.8, to review the design and to identify issues and potential interoperability problems. During the procedure at each checkpoint, the assessment teams will document and identify any conformance barriers or problems. If problems are discovered, remedial actions will be developed and implemented. Progress toward resolution should be tracked, and action assignments and resolutions should be documented to serve as a monitoring and lessons learned tool for future CVO deployments. The steps of the CAP are summarized in the Table 7-4.

The CAP recommendations are based on lessons learned from early ITS/CVO projects. These processes steer the projects toward architecture conformance, interoperability, and user satisfaction. Each step involves specific activities on the part of the management and development teams and specific completion criteria. The recommended CAP is closely integrated with the overall deployment process as shown in Figure 7-4.

**Table 7-3 Architecture Conditions and Conformance**

| Required Architecture Conditions |
|---|
| **The following required conditions on recipients are under consideration for inclusion in the NPRM:** |
| Use the interface standards recommended for ITS/CVO. |
| Ensure via testing that ITS/CVO systems are technically interoperable at the hardware and systems/software level. |
| Ensure ITS/CVO systems are interoperable at the operational level. |
| Ensure ITS/CVO systems are interoperable at the program administration level. |
| **Required Architecture Conformance** |
| **The NPRM may possibly also recommend that project teams use these processes to achieve the required architecture conformance:** |
| Complete and maintain a Business Plan that encompasses all ITS/CVO activities in the state or region. |
| Attend the ITS/CVO technical training courses sponsored by FMCSA. |
| Attend a series of CVISN Deployment Workshops designed to assure architecture conformance and interoperability of deployed systems. |
| Complete and maintain a Program Plan that encompasses all CVISN projects or efforts in the state or region. |
| Complete and maintain a System Design that describes the top-level design for all planned changes or additions to CVISN-related systems or products. |
| Submit CVISN deployments to standard interoperability tests to verify architectural compatibility. |
| Follow the ITS/CVO Architecture Conformance Assurance Process. |

**Table 7-4 Conformance Assurance Process Steps**

| Phase | Who | Task |
|---|---|---|
| Program Initiation | Program Team | The lead agency and stakeholders within the state/consortium should sign a Memorandum of Agreement (MOA). The MOA should commit them to the program and the ITS/CVO objectives as well as to being in conformance with the National ITS architecture and CVISN architecture and standards. |
| | COAT | Verify that the COACH Part 1 checklists have been completed and reflect commitments to the CVISN architectural and operational concepts. |
| Top-Level Design | Program Team | The lead agency should follow best program management practices as demonstrated through strategic business planning and CVISN program planning. It should define a top-level design consistent with the ITS/CVO and CVISN architectures. |
| | COAT | Assess the program plan and project plans and top-level design and verify conformance with the CVISN architecture as specifically defined in COACH Part 2. |
| Detailed Design | Program Team | Develop an ITS/CVO detailed design that is consistent with appropriate CVISN design features and standards. |
| | COAT | Assess the detailed design and verify conformance with the CVISN architecture as specifically defined in COACH Part 3 and 4. |
| Implement | Program Team | Design and develop each subsystem. Integrate each subsystem into a working whole system. |
| | COAT | No activity. |
| Test | Program Team | Test for functionality, performance, and interoperability. |
| | COAT | Assess implemented subsystems and verify conformance with the CVISN architecture (as specifically defined in COACH Part 5) through interoperability testing using standard test cases supported by the FMCSA. Help to tailor tests and analyze results. |

## 7.7 How is Interoperability Testing Done?

Interoperability tests are standardized interface tests. Their purpose is to test if the systems under test are in conformance with the architecture. By checking for conformance with the architecture, interoperability tests are intended to verify that independently developed ITS/CVO systems will work together to accomplish a shared function. The tests are primarily focused on verifying that interfaces are built according either to ANSI ASC X12 EDI standards and Implementation Guides or to ASTM and IEEE standards for DSRC. The tests verify that the systems can use common message formats to exchange data and that the data has the same meaning to all (e.g., a particular status bit set means “IRP application accepted”). They also verify that the systems exchange sequences of messages as required to carry out some overall function (e.g., IRP registration application, processing, invoicing, and payment).

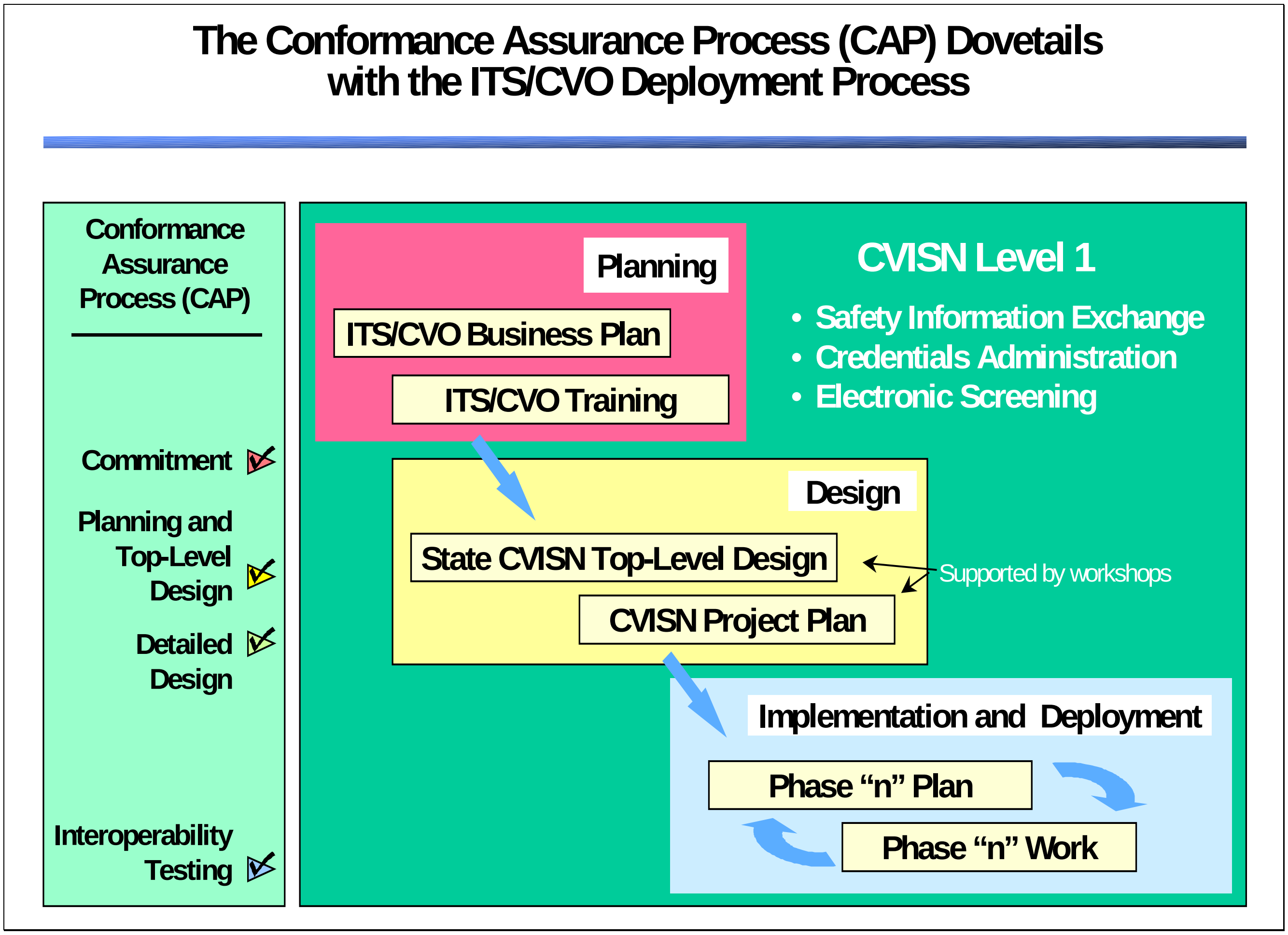


**Figure 7-4 CAP Dovetails with ITS/CVO Deployment Process**

The interoperability tests are developed once and then used by many jurisdictions. They can be used during initial system development and for regression testing (repeating tests previously passed by earlier system versions) as systems are updated. Executing the interoperability tests is the final part of the conformance assurance process.

There are two types of interoperability tests: **pair-wise** and **end-to-end**. Pair-wise tests verify that interfaces between selected pairs of products or systems meet the applicable standards. End-to-end tests verify data flow and data usage among all required products or systems from initial input through final outcome.

Figure 7-5 shows an example of a pair-wise test. The system under test is a CAT system. A standardized test suite package has been developed for this test. A CVISN Test Facility has been established at The John Hopkins University/Applied Physics Laboratory (JHU/APL) that can be used to support test execution. The carrier can follow the procedures provided in the test suite package and use the test data provided there to submit EDI transactions to the test facility, just as it would to a state system. The test facility will respond to the transactions just as a state system should. This allows the motor carrier (or their vendor) to test the CAT software against a known system that conforms to the architecture.

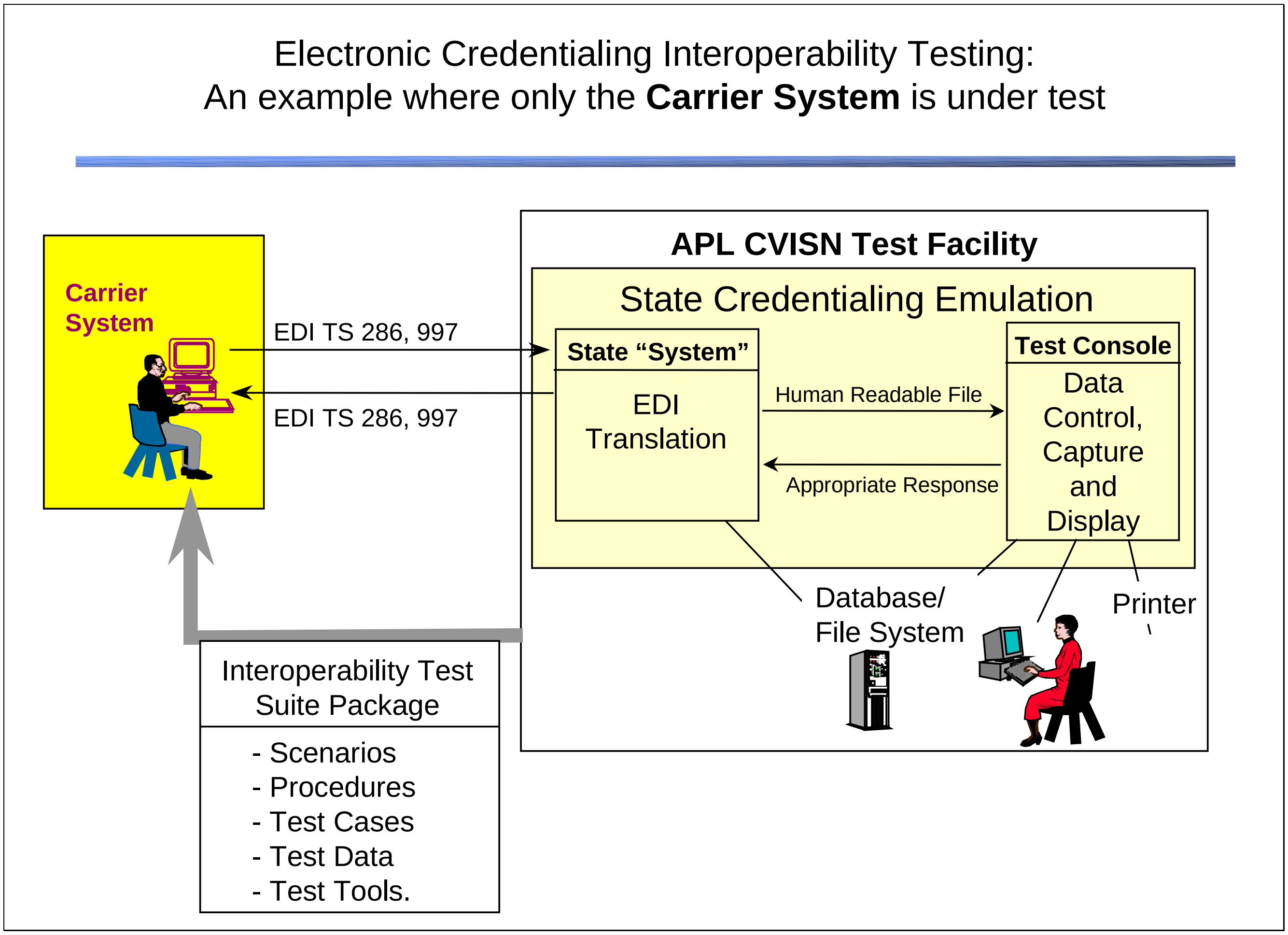


**Figure 7-5 Electronic Credentialing Interoperability Testing**

Standardized interoperability test suites are being developed to test selected, critical aspects of interoperability. The process for developing and using the interoperability tests is illustrated in Figure 7-6. JHU/APL is developing 22 pair-wise test scenarios (of 250 possible) and 13 end-to-end tests (out of 75 possible). The tests cover selected aspects of safety information exchange, credentials administration, and electronic screening. JHU/APL has the responsibility to develop the tests and the CVISN Test Facility. States and carriers have the responsibility to execute the tests. JHU/APL can provide support to the test execution at the option of the state.

## 7.8 Who is Responsible for Ensuring Conformance?

A COAT should be established to evaluate ITS/CVO projects at various checkpoints in the deployment cycle. The roles and responsibilities of stakeholders involved in the process of assuring consistency are described below and illustrated in Figure 7-7.

**Lead Agency –** The entity allocating funds or responsible for program management will be accountable for meeting program and project goals and objectives.

**Conformance Assessment Team –** The COAT should consist of, at a minimum, the program system architect, an ITS/CVO specialist from the FHWA Division Office, an ITS/CVO specialist from an FMCSA Service Center, and an architecture and standards expert. The system architect leads the COAT.

The ITS/CVO specialists from Division Offices and Service Centers will participate in the COAT. They will have the ultimate responsibility and authority to certify that designs and implementations are in conformance with the architecture.

The architecture and standards expert should be someone very familiar with the ITS/CVO architecture and standards, the experiences of the CVISN model deployment states, and the CVISN Core Infrastructure systems. This expert is probably a consultant hired by the state, but may occasionally be a state employee, such as an employee of a state university. The architecture and standards expert is an on-call consultant (especially during the requirements and design phases) who reviews the products of those phases, helps tailor the interoperability tests, and may help analyze the test results. This expert reviews technical documents and the results of interoperability tests and provides their findings to the other members of the COAT. Each expert can work with several states so that the cost for each state is minimized.

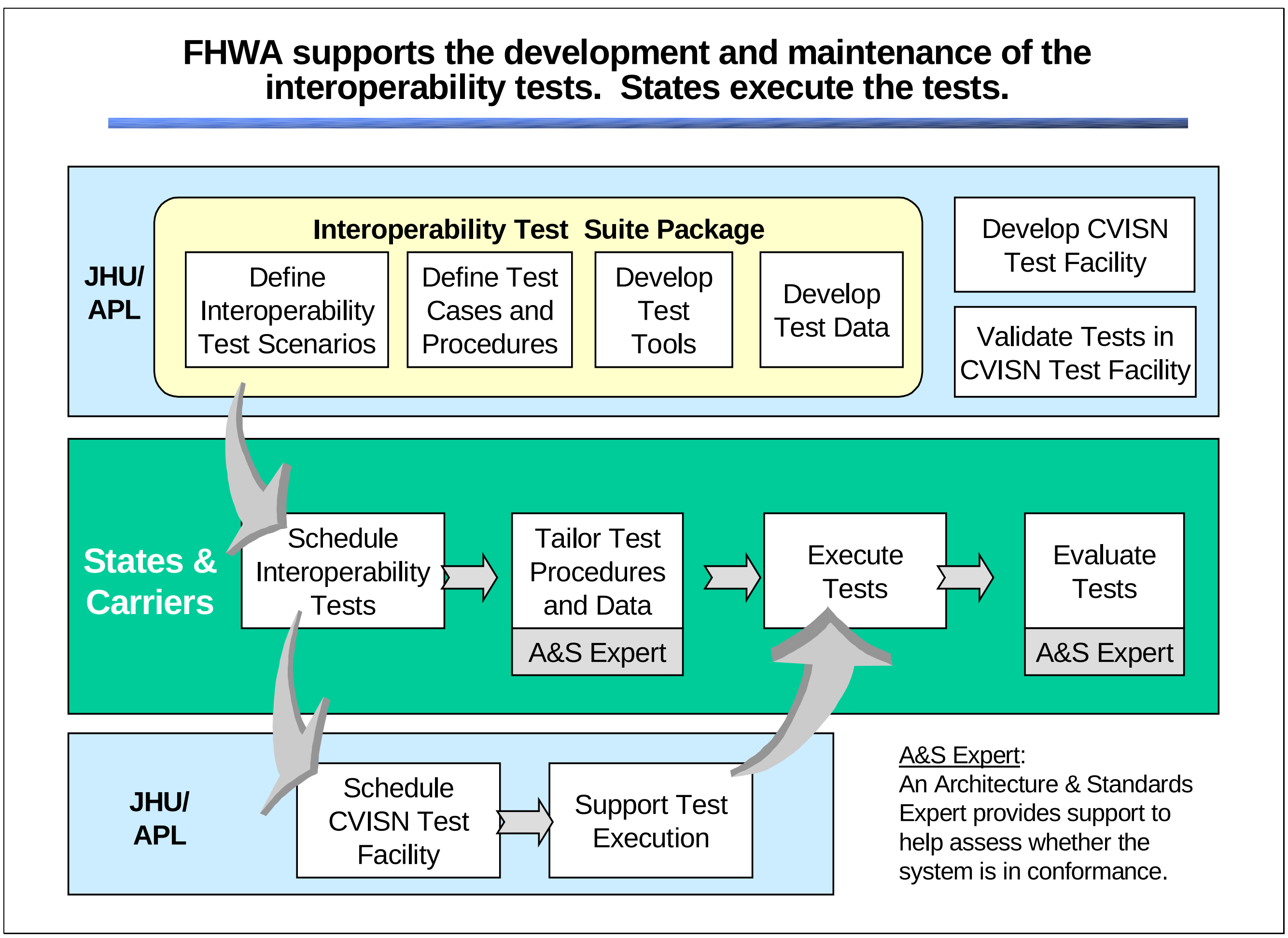


**Figure 7-6 Development of Interoperability Tests**

The COAT functions as an occasional team. The FHWA Division Office representative and the state system architect are likely to work in the same area and be able to get together for meetings. The FMCSA Service Center ITS/CVO expert and the architecture and standards agent may be more remotely located and may often attend via teleconference or video conference.

**Interoperability Testers –** The interoperability test team should include system users and independent testers. The COAT may assist the interoperability test team in tailoring the standard test suite package and in evaluating the test results. The FMCSA is supporting the initial CVISN Level 1 interoperability test capability through sponsoring construction and maintenance of reusable test plans, test cases, and test data.

## 7.9 What Guidance is Available for Conformance Assurance?

This chapter provided an introduction to ITS/CVO architectural conformance assurance. More information on this specific topic of conformance can be obtained from the FMCSA's *ITS/CVO Conformance Assurance Process (CAP) Description* and the COACH. In addition, the whole approach of training, workshops, guides, and management recommended by the FMCSA for ITS/CVO deployments is designed to work with a CAP in a way that minimizes risks by leveraging the past experience of others. Figure 7-8 summarizes the CAP.

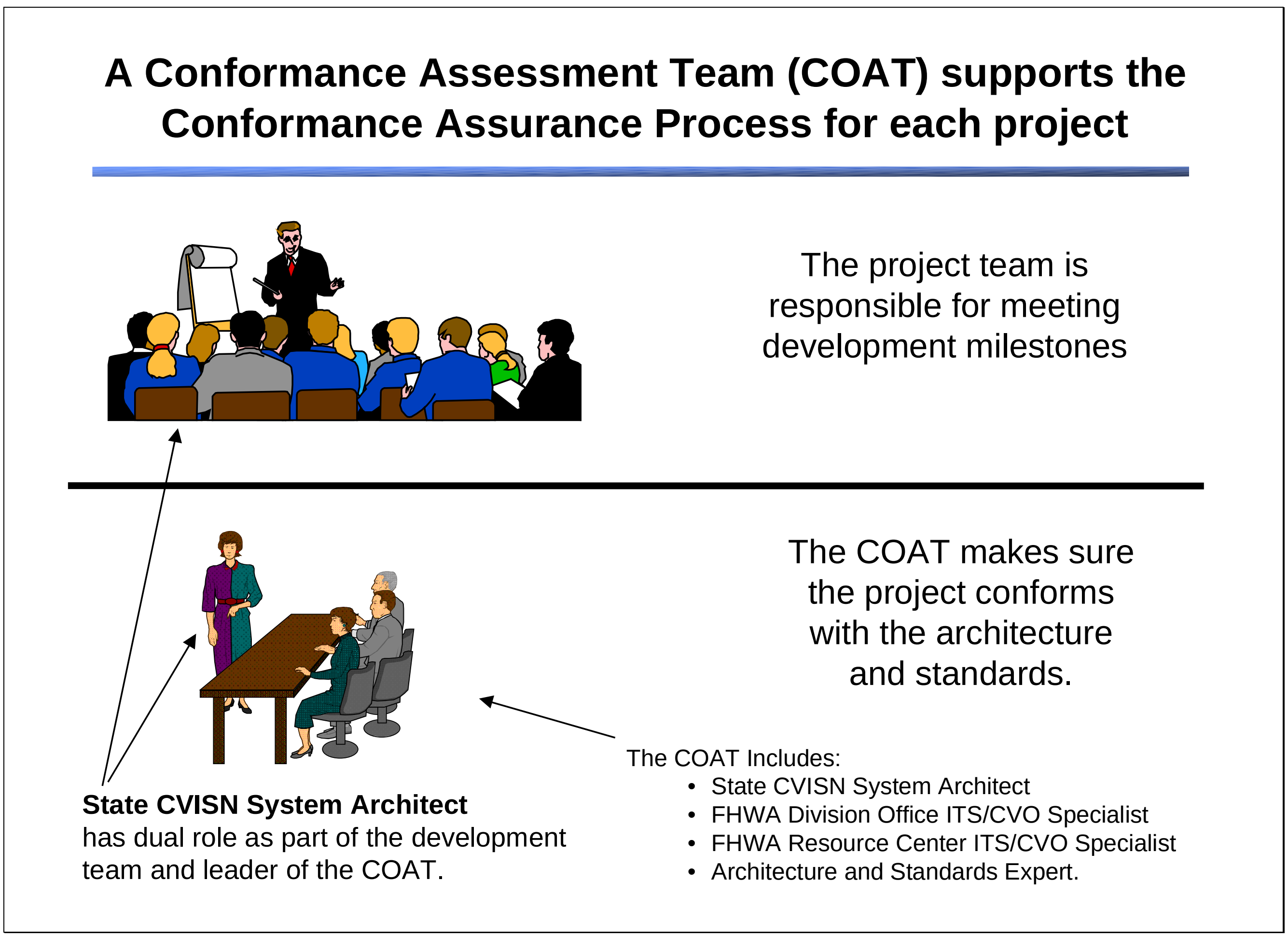


**Figure 7-7 Interoperability Test Team**

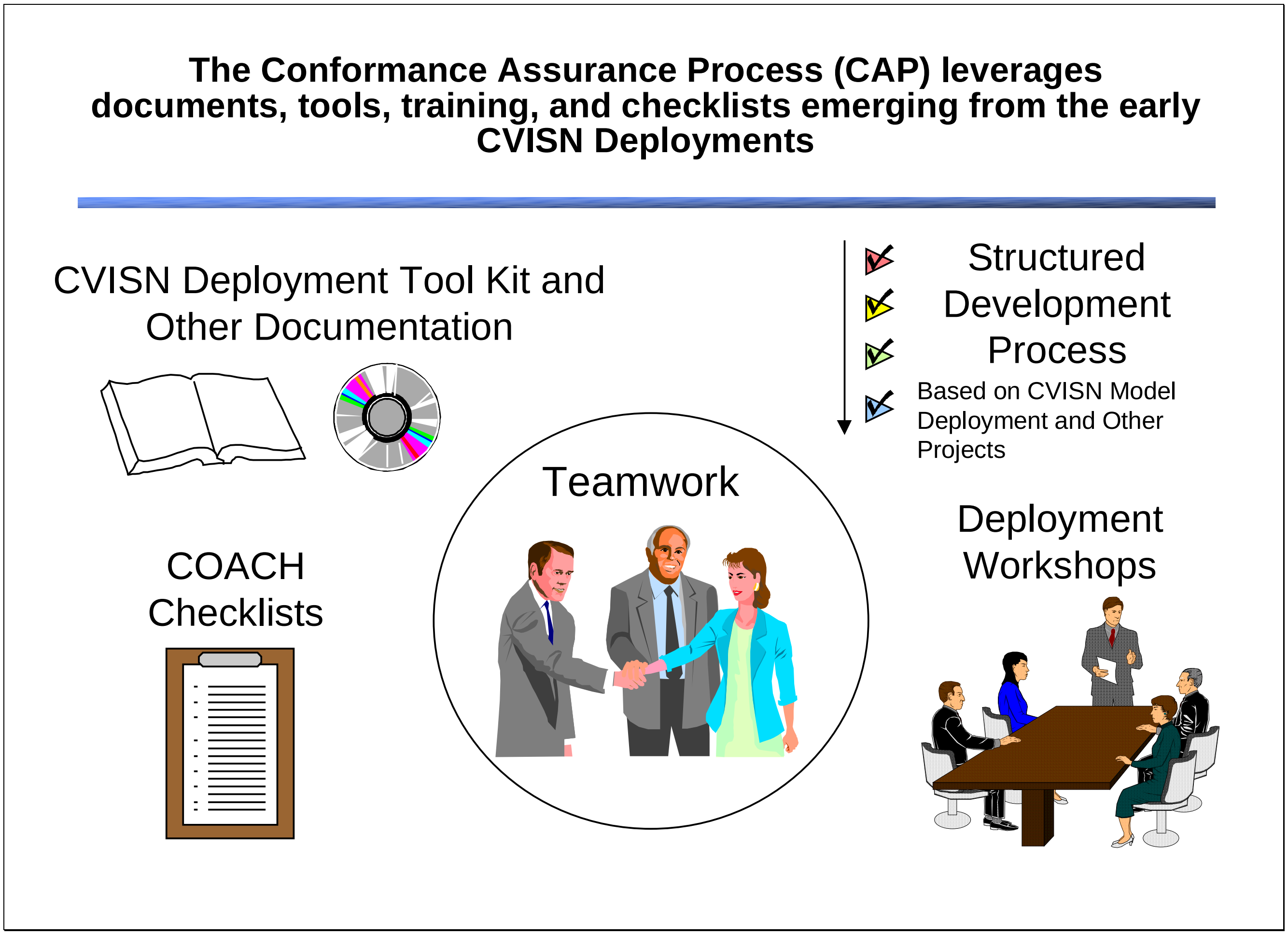


**Figure 7-8  Conformance Assurance Process**